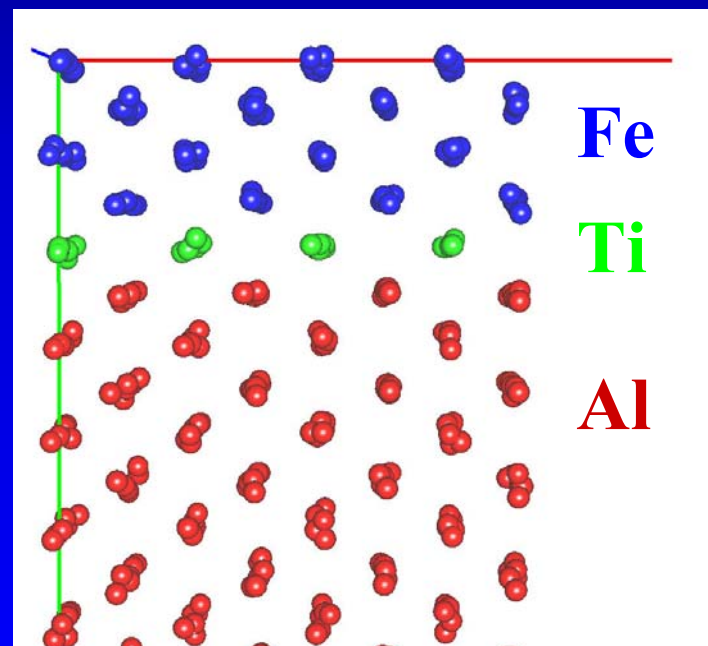
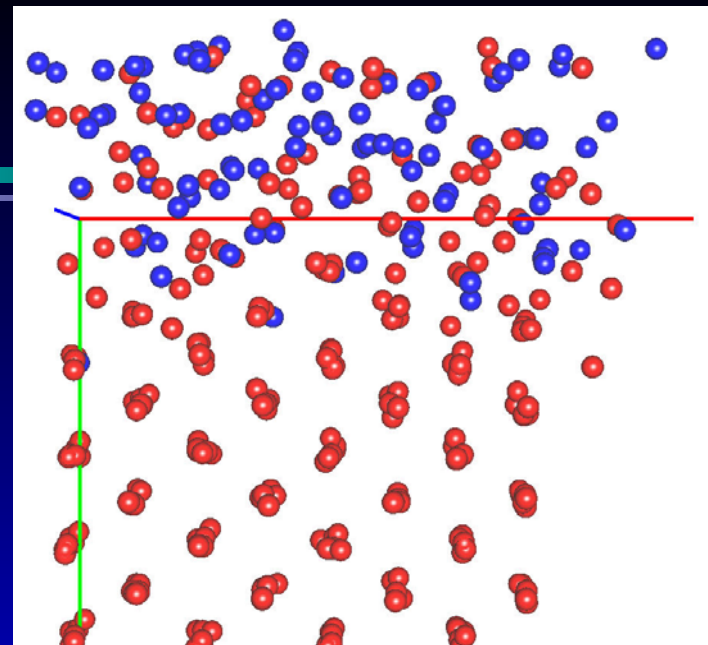
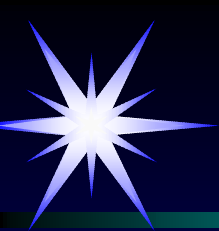




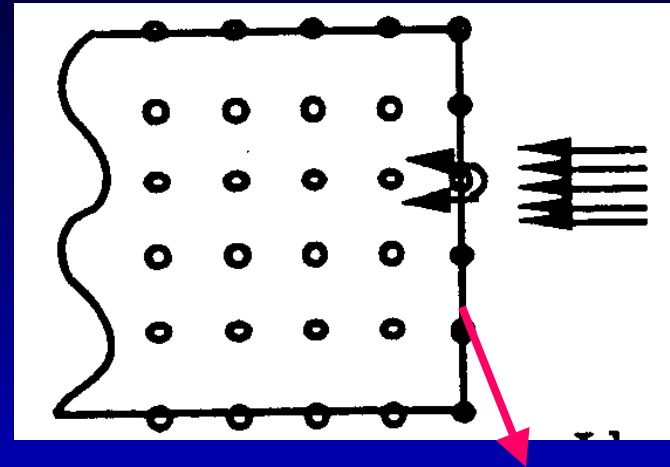
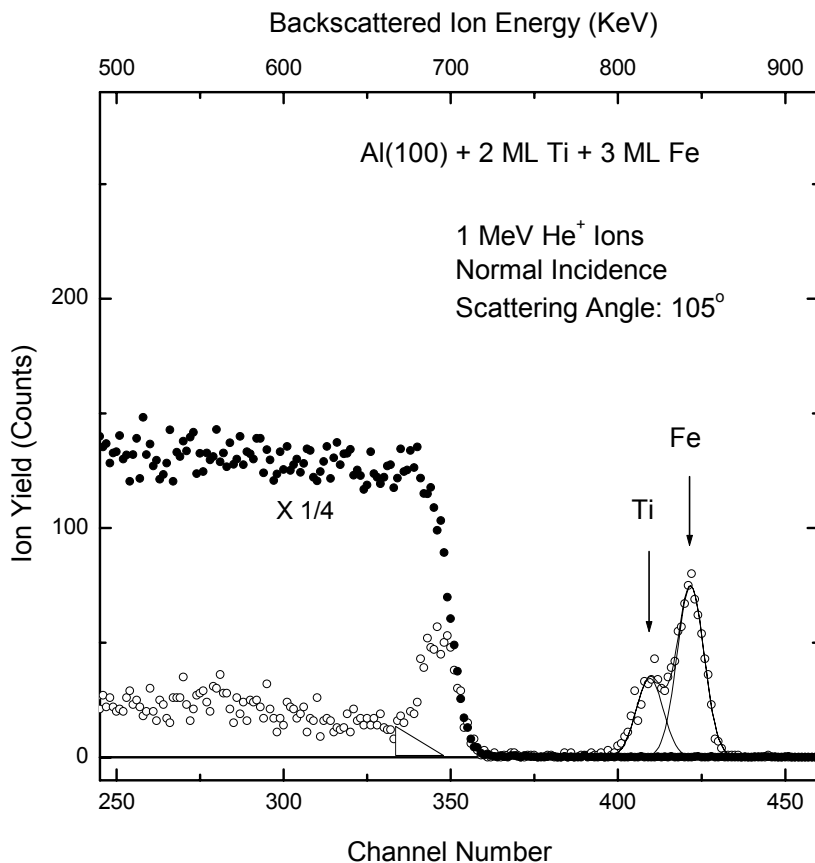
# Controlling Interface Structure Using Metallic Interlayers

- Goal: stabilize the metal-metal interface, inhibit interdiffusion, provide a template for epitaxial growth
- Upper: Snapshot from Monte Carlo simulations for Ni-Al interface; alloying typical of transition metal-aluminum interfaces
- Lower: Ordered overlayer growth with ideal interlayer

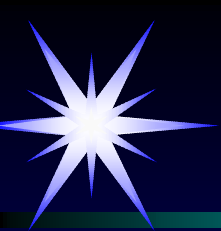




# Overview of High Energy Ion Backscattering and Channeling



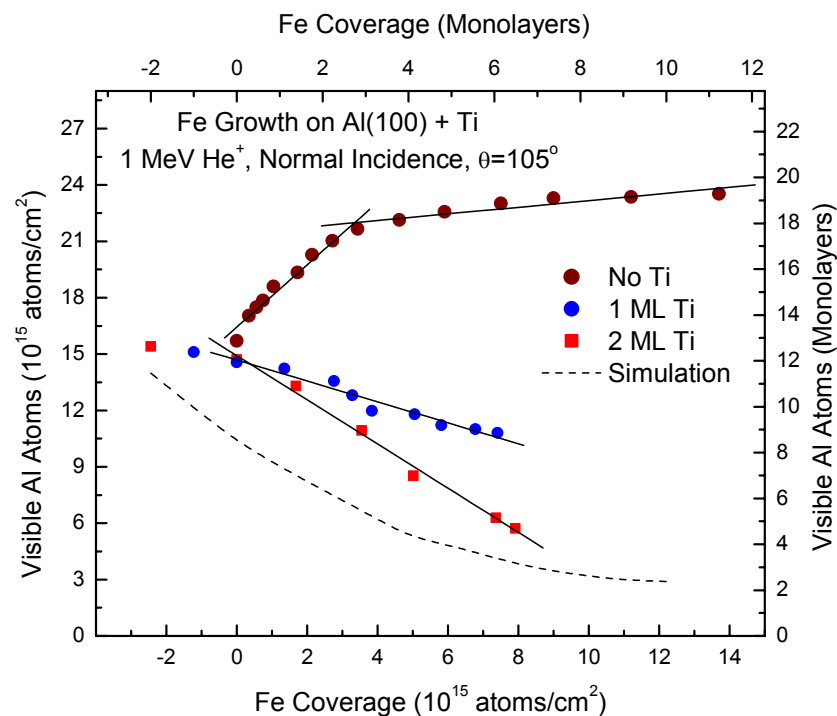
- Quantitative measurements
- Fe (Ti) peak for film coverage
- Al surface peak (SP) for film structure
- Alloy  $\Rightarrow$  Disorder increases SP
- Overlayer  $\Rightarrow$  Shadowing decreases SP



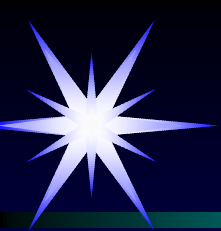
# Controlling Interface Structure using Metallic Interlayers

Richard J. Smith, Montana State University, DMR 0077534

- No interlayer – visible Al atoms increase as deposited Fe atoms disorder the surface
- 1 Ti layer – visible Al atoms *decrease* as Fe atoms cover the Al atoms!
- 2 Ti layers – more complete shadowing of Al substrate
- Simulation (---) for ordered Fe film on the Al substrate



**Training: Accelerator-based techniques and surface spectroscopy**  
**Personnel: Graduate (3) and undergraduate (9) students; Postdoc and sabbatical visitors (3); high school teacher (1)**



**Understanding the technique:** Rutherford backscattering and channeling (RBS/c) along with low-energy electron diffraction (LEED) and low-energy ion scattering (LEIS) were the primary techniques used in the present work. In the channeling geometry a 1 MeV  $\text{He}^+$  beam is incident along a low-index crystallographic direction. The energy spectrum of backscattered He exhibits a surface peak (SP) associated with ions backscattered from the topmost layers of the solid. Incident ions missing the target nuclei by more than a few tenths of an Angstrom are essentially undeflected and channel along the relatively open region between the rows of atoms. These trajectories define the “shadow cone” which can be visualized as centered on and extending along a line starting at each surface atom. A surface atom displaced by a few tenths of an Angstrom uncovers the next atom along that row and the backscattered ion yield increases. An adatom of another species sitting directly above a substrate atom shadows that atom and reduces the backscattering yield from substrate atoms. The SP areas are converted to areal densities of visible target atoms ( $\text{atoms}/\text{cm}^2$ ) using the known Rutherford scattering cross section and experimental parameters.

**FIG. 3 (slide).** Visible Al atoms, for 1 MeV incident He ion energy, as a function of Fe coverage for deposition at room temperature on Al(100). The upper curve (brown) shows the increase of the Al surface peak area for a series of Fe depositions with no Ti interlayer. The increased yield is attributed to alloy formation and disorder at the surface. The lower panel shows the decrease of the Al surface peak area as a function of Fe coverage with one (blue) and two (red) Ti interlayers deposited on the clean Al surface prior to Fe deposition. The decrease is attributed to shadowing by an ordered Fe overlayer. The broken line shows the calculated behavior expected for an ideal, epitaxial Fe overlayer.

**Training:** The Ion Beam Lab with its combination of accelerator-based techniques and electron spectroscopy for surface analysis is one of just a few such university-based labs in this country training graduate and undergraduate students, postdocs and sabbatical visitors, and high school teachers (with support from Murdoch foundation). NSF support makes possible the operation of our Nobel Laboratory Series of experiments. (NSF-ILI program 1990). The number of students supported during the current grant are shown in ( ) in the slide.